Integrated Variable-Fidelity Tool Set For Modeling and Simulation of Aeroservothermoelasticity -Propulsion (ASTE-P) Effects For Aerospace Vehicles Ranging From Subsonic to Hypersonic Flight, Phase I

Completed Technology Project (2007 - 2007)

Project Introduction

The proposed research program aims at developing a variable-fidelity software tool set for aeroservothermoelastic-propulsive (ASTE-P) modeling that can be routinely applied to the design of aerospace vehicles. The tool set can be applied to conventional vehicle types as well as hypersonic vehicles. The major issues involved in ASTE-P modeling and simulation will be significantly and extensively investigated in this project, which include full coupling between fluid/structure/control dynamics, the aeroservothermoelastic-propulsive instability, the viscous/turbulent effects, shock and shock-boundary layer interaction, as well as the large unsteady and highly nonlinear aerothermal dynamic loading on structure of vehicles. The interface of the structure/control surface dynamic vibration modes with flows will be modeled using particle-based material point method (MPM) in an integrated dynamic fluid-structure interaction environment. The MPM is essentially a particle-based method which avoids dealing with the time-varying mesh distortions and boundary variations due to structure/control surface deformations and/or motions (i.e. wing flutters, FCS/structural mode interaction, PSD turbulence response), thus being significantly more robust and computationally efficient than the traditional finite element methods that must utilize moving-boundary and mesh-regeneration. Phase I will build and demonstrate the initial capability; the end software in Phase II will be fully capable of ASTE-P analysis and evaluation for aerospace vehicles.

Anticipated Benefits

The resulting methods and software ability will, of course, benefit other DoD components, such as Army, Navy and Air Force. The US aerospace industries, including Boeing, Pratt & Whitney, General Electric, General Dynamics, Lockheed Martin, Textron, and others, will be the major non-military potential customers. Moreover, improvement of computational accuracy and efficiency is common interest in CFD/CSD community, thus is highly demanded. The aerospace industries in Europe, China and Japan represent another large potential marketing of the resulting methods and software. Advanced Dynamics will promote the international sales through resale partners of local companies abroad. Therefore, the methods and software abilities gained from this SBIR project will be additional to Advanced Dynamics' existing commercial offerings. The development of variable-fidelity aeroservothermoelastic-propulsive analysis and modeling capability will benefit the testing and clearance of aerospace vehicles in NASA Centers by providing an essential design tool that is not currently available. The end software will be applicable to various aerospace vehicles from conventional types to spacecrafts, and would greatly increase the safety and efficiency of flight testing and clearance. The benefit in terms of improved specification, design and operational

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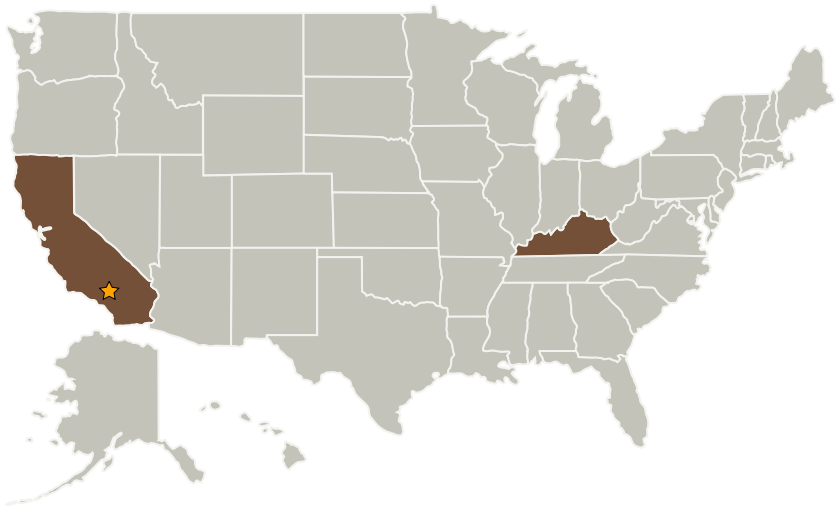
Completed Technology Project (2007 - 2007)

performance for diverse aerospace vehicles will potentially lead to savings in project time and cost, and increase the US space mission effectiveness.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Armstrong Flight Research Center(AFRC)	Lead Organization	NASA Center	Edwards, California
Advanced Dynamics, Inc.	Supporting Organization	Industry Minority-Owned Business	Lexington, Kentucky

Primary U.S. Work Locations	
California	Kentucky

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Armstrong Flight Research Center (AFRC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Project Manager:

Martin J Brenner

Principal Investigator:

Patrick Hu

Technology Areas

Primary:

- TX15 Flight Vehicle Systems
  - TX15.2 Flight Mechanics

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Technology Areas *(cont.)*

- TX15.2.2 Flight Performance and Analysis